eLORAN: Global, Resilient & Co-Primary PNT to Protect Against GPS/GNSS Disruptions

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L3HARRIS

Microsemi
a MICROCHIP company

MACQUARIE

Booz | Allen | Hamilton

Continental Electronics
"A Tradition of RF Innovation"

The Right Team - Purpose Built for eLORAN

Experts in PNT, able to delivery the right capabilities, globally

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GPS/GNSS Vulnerability

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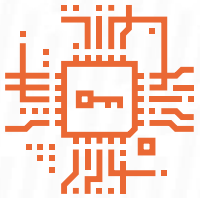
GPS/GNSS: Susceptible to many forms of Disruption

Spoofing (fake GPS signals)
-covert (Iran high jacking navy ships)
-deception (tricking tracking devices)

Multipath
-Signal splitting reflection

Interference
-intentional (jamming)
-unintentional

Weak GPS/GNSS signals make it vulnerable to:



Cyber-Attacks
-Non-Signal Issues

GPS Satellite Transmit Errors
-Erroneous update data
-Corrupted software
-Failed updates (Jan 26, 2016)

Atmosphere
-Storms/weather
-Scintillation
-Solar flairs/activity

PNT Resiliency and GPS/GNSS Independence is an international security protection priority

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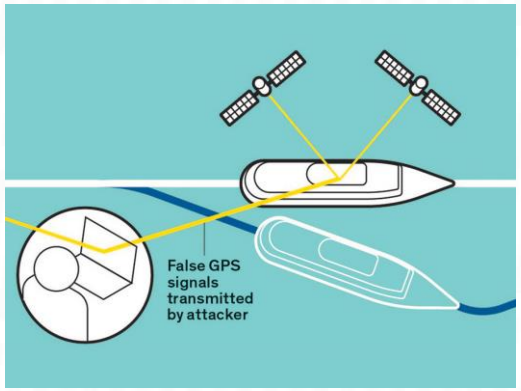
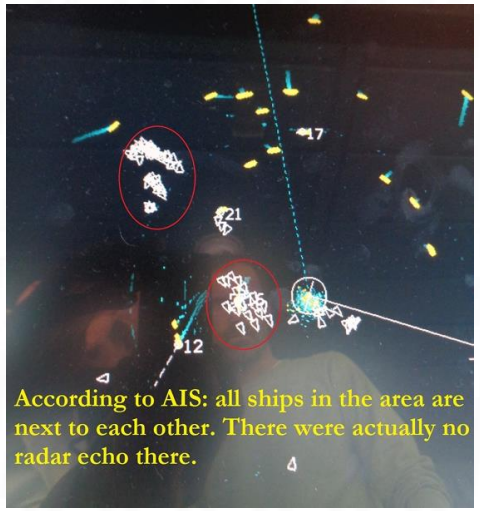
GPS/GNSS Jammers/Spoofers: Affordable, effective, proliferating



GPS spoofing: How Iran tricked US patrol boats into capture



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GPS/GNSS Disruption & Spoofing is a Global Problem

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1.2K

DAILY NEWS 10 August 2017

Ships fooled in GPS spoofing attack suggest Russian cyberweapon

AUTO SHOWS » GENEVA MOTOR SHOW

There's Something Very Weird Going on W GPS Systems at the Geneva Motor Show

Jason Torchinsky
3/08/19 2:26pm • Filed to: GENEVA MOTOR SHOW

57.7K 115 3

As you may know, the Geneva Motor Show public days are this week, and

Los Angeles Times

3 FREE MONTHS
Offer ends 10/2

rs of smog: Southern California w its longest streak of bad air in es

The law finally catches up with Suge Knight: A timeline

Father of NBA player Richard Jefferson killed in Compton drive-by shooting

Suge Knight could serve up to 28 years after pleading no contest in 2015 hit-and...

What if we lost GPS? That's one thing worrying the Air Force secretary

By SAMANTHA MASUNAGA DEC 19, 2017 | 7:00 AM

The Barents Observer

Russian military training along the border. Photo: Mil.ru

Norway requests Russia to halt GPS jamming in borderland

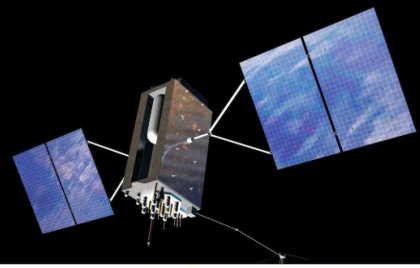
Intensive military training on the Russian side of the border creates increasing communications troubles for nearby Norwegians.

By Atle Staalesen

Bloomberg Businessweek

The World Economy Runs on GPS. It Needs a Backup Plan

The small satellite network, which keeps global computer systems from freaking out, is shockingly vulnerable to all kinds of interference.



INSIDE GNSS NEWS

Newark Liberty International Airport. Port Authority photo

FCC Fines Operator of GPS Jammer That Affected Newark Airport GBAS

Jamming events continue — an average of five per day at EWR

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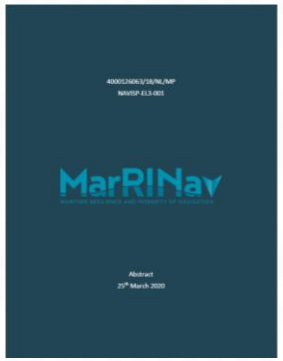
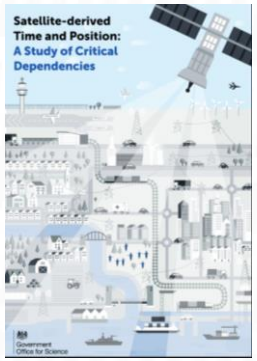
Sample of Global Independent Reports: GPS/GNSS is critical and vulnerable; eLoran is an ideal solution for a backup



UK GLA



UK Blackett

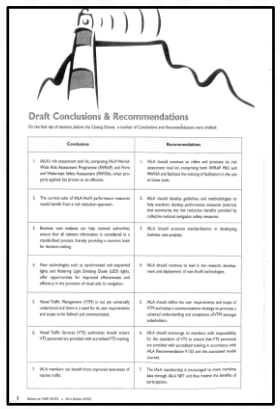
US DOT

UK SA

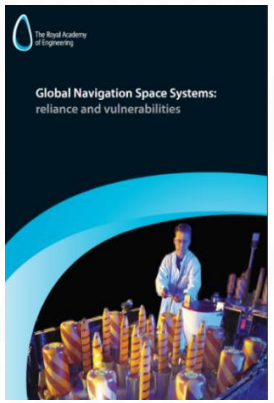
UK RAoE

US NDP

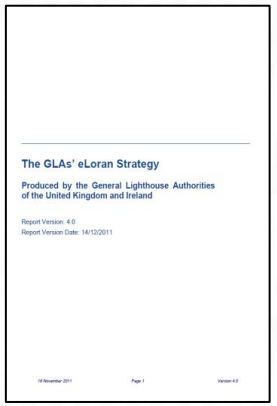
SENTINEL



IALA



UK RAoE



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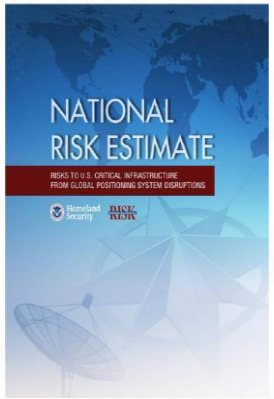
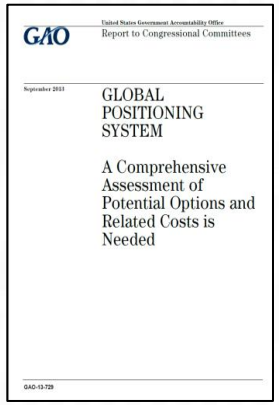


US DHS



US GAO

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eLORAN: Resilient PNT

Signals in Space and User Equipment

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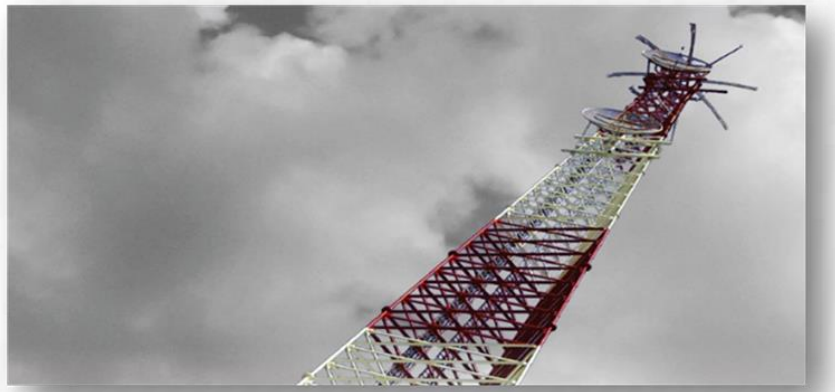
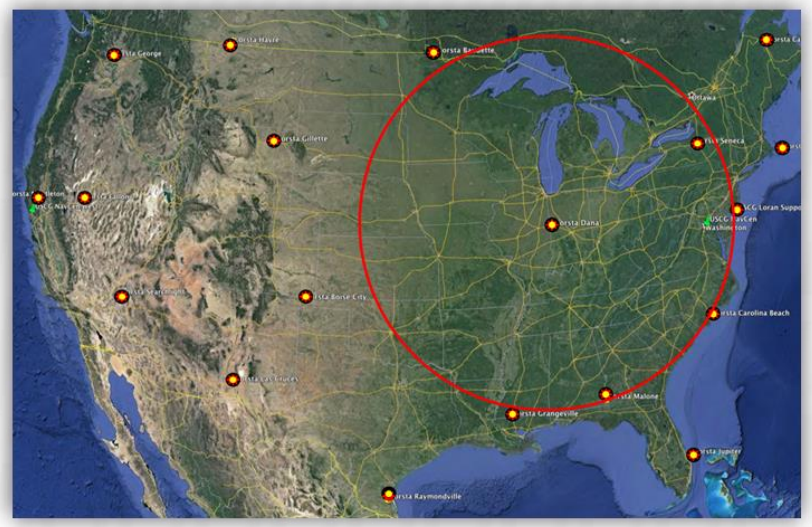
eLORAN: Resilient, Independent Back-up and Enhancement for GPS

Enhanced Long Range Navigation (eLORAN) is a proven, land-based signal transmitted from 19 tower for national coverage. Invented in WWII and used through the 2010. ***eLORAN is virtually immune to the weaknesses of GPS: "No common failure modes with GPS/GNSS or space systems"***

eLORAN attributes: range of 1,200 miles, can penetrate into buildings, tunnels, and is ***3-5 million times stronger than GPS*** making it nearly jam proof, while providing the same capabilities as GPS – ***and eLORAN can work where GPS can't***

The LORAN-C system has been sitting idle since 2010. It can be resurrected, modernized and go operational as eLORAN quickly to reduce our risk threat. The 19 existing towers provide full PNT coverage for the United States to backup GPS and ***act as a Co-Primary and interoperable PNT system to GPS/GNSS, given greater combined capabilities and accuracy then either alone***





The 19 legacy US eLORAN Towers: This circle represent the effective range of single tower

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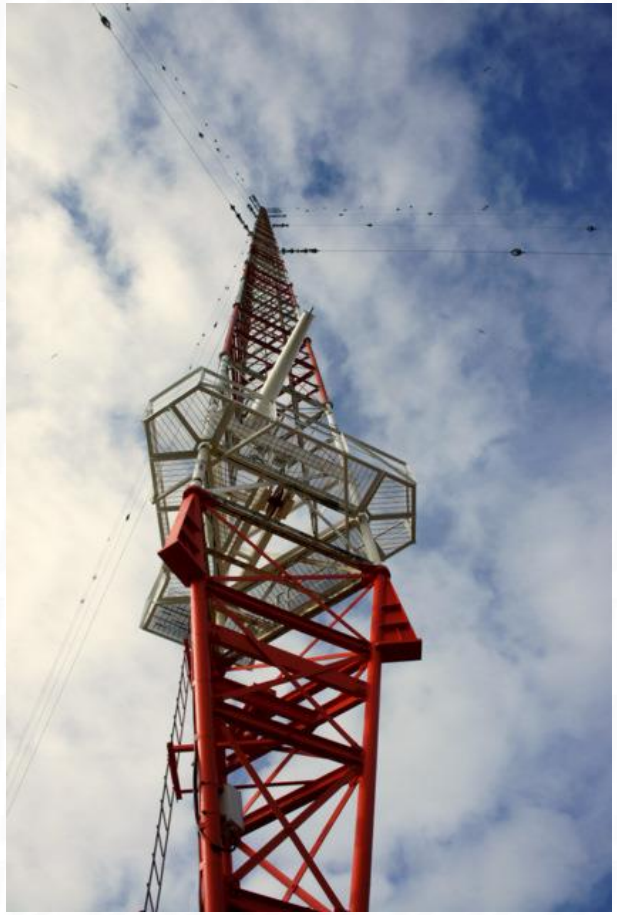
eLoran: Low Frequency, High Power, Ground Based

- Now operating, UK Anthorn site transmitting
- ***Unmanned / autonomous operations (low cost)***
- <99.999% availability. Air, land & sea, wearable PNT
- Terrestrial, Independent but interoperable with GPS/GNSS or any other PNT system
- Range of ***1,200-miles per tower*** reduces required infrastructure 1 for timing, 3 for position & navigation
- Spectrum (100 kHz) internationally protected, free worldwide
- Up to 1MW transmits power, signal nearly impossible to disrupt
- Useable anywhere ***indoors & underground, underwater (2m)***
- User antenna ***integrated with receiver***, no need for roof or external instillation – fully integrated user equipment



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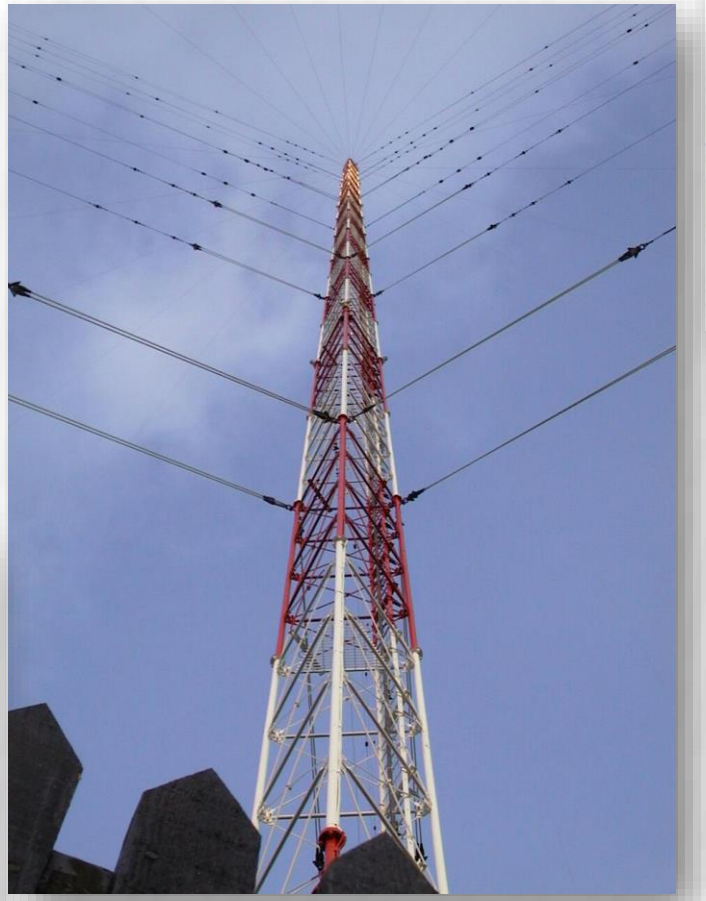
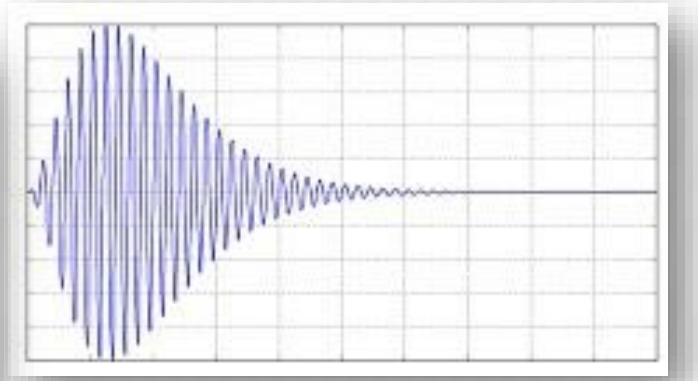
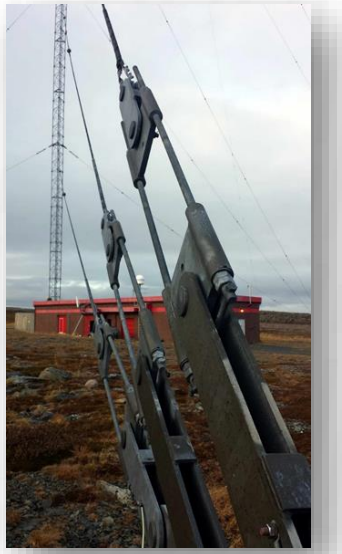
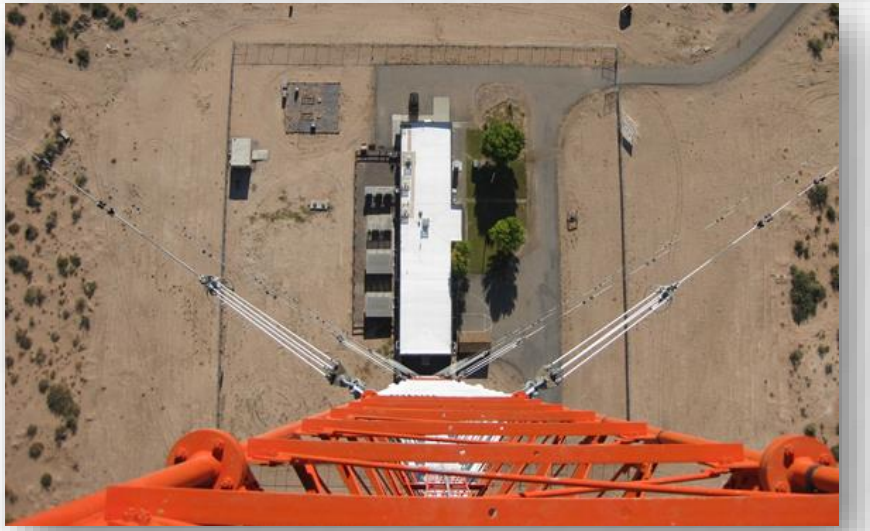
eLORAN: 19 USG Towers/Stations for National Coverage









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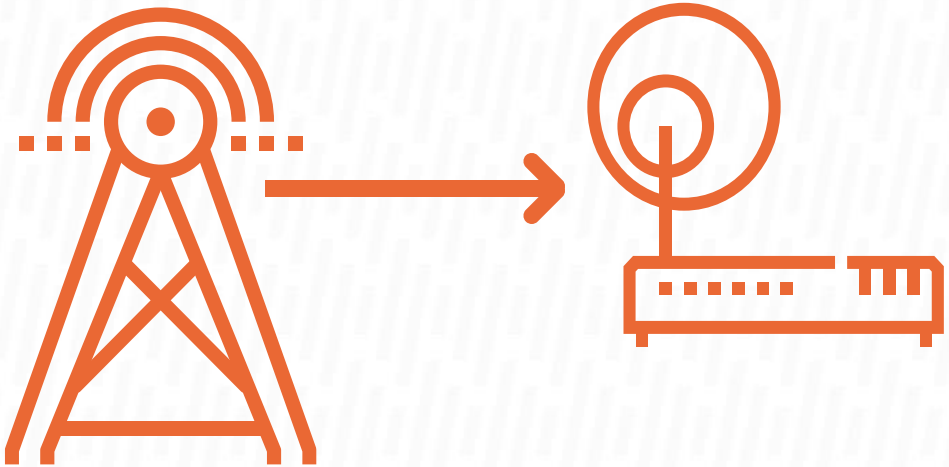
LDC – LORAN Data Channel – "9th Pulse" – One Way Data

- The LDC is a channel within the high power eLORAN signal capable of 1-way data communications
- Multiple data channels per eLORAN station available
  - LDC range extends to 1,200 miles; LDC strength virtually 100% at 1,200 miles
  - Additional stations = additional 9th pulses = more data
- LDC uses include:
  - Encrypted, mission specific data messaging/SW updates
  - Authentication of eLORAN broadcasts (anti spoofing)
  - Secure, un-jammable command and control
  - Penetrates all structures, weather, underground, etc.
- Alternate LDC techniques can provide extended range and/or higher data rates (> 1000 bits/second)
  - Potential expansion of bandwidth by 8x



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eLoran User CONOPS

PNT and Beyond

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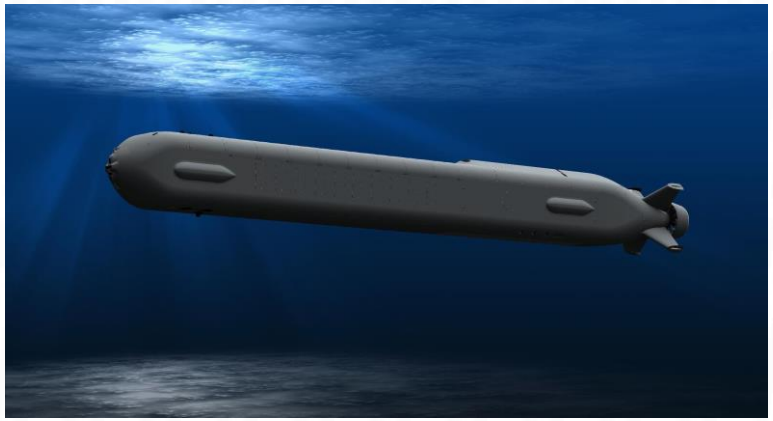
Unmanned/Autonomous Systems, Navigation & Control w/LDC

- Assured navigation of all UAS (Air, land, sea, subsurface)
- Near Immune to jamming and spoofing
- Small, lightweight, inexpensive user equipment: receive & antenna integrated
  - 1 watt receiver, 2-3 watts antenna
- User equipment SWaP requirements ideal for small craft
- Command capability: go to location, return to home, control a swarm
- Activate a system: turn on/command a camera, avoid, destruct
- Truth detection of GPS errors
  - When eLORAN and GPS diverge



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Former LORAN-C Sites: Easily Reconstituted to eLoran

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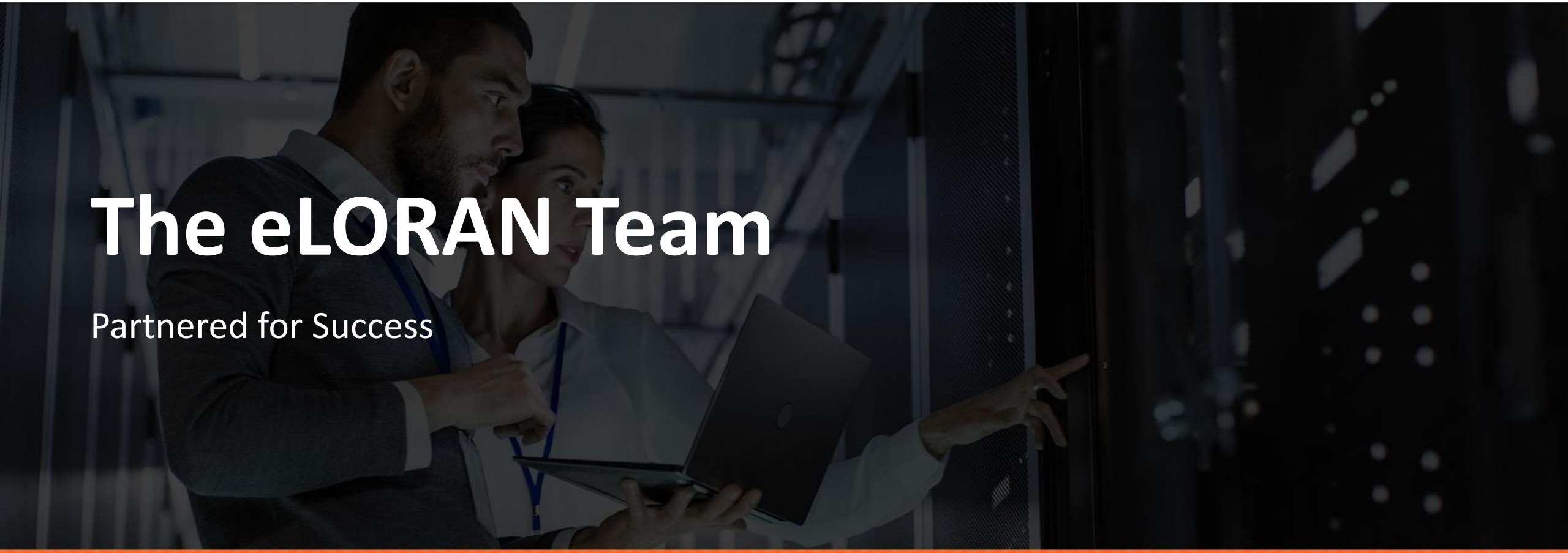

The eLORAN Team

Partnered for Success

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Contact Information

Bridge Littleton: bridge.Littleton@hellensystems.com

571-276-7730

Hellen Systems: Joint Venture Team

- Hellen Systems
  - Core background in private equity partnerships, government contracting, capital market structure, financial modeling & operations/legal
  - Broad experience company acquisition and build (100+ companies, total enterprise value of $1.5b)
  - Leading core team development, commercial market strategy development, primary capital raise and lobbying/advocacy efforts
- Macquarie Capital USA
  - US infrastructure focused private equity firm based in New York City
  - $395 billion assets under management, $17b in annual revenues
  - Extensive background in infrastructure related public private partnerships
    - Kentucky Wired: $1.8b fiber optic deployment PPP, service fee & hook up revenue model for 20 year period, Boston Skyway: $780m transportation project, Goethals Bridge: $11b, Freeport Energy (LNG) $15b in financing for large plant

Leaders in eLORAN and PNT: Harris Corporation & Microsemi

- Harris Corporation: $17b in annual revenues
  - Primary business areas: Network deployment, tactical radios, space based systems (GPS), radar & avionics, and engineering services and design
  - Focus areas include complex, nation-wide network system design, deployment and operations, ground based system operations and
    - FAA ADS-B Program: $2.2b, 20 year, GPS positioning & ground based aircraft surveillance system operationalized through an integrated network of 650 ground stations – Won in 2007, PPP with the FAA & $100m company investment
- Microsemi Corporation: $2b in annual revenues (wholly owned subsidiary of Microchip Corporation - $7b annual revenue)
  - The industry leaders in time, frequency, and synchronization solutions for the US government, commercial, and national critical infrastructure operators
    - Sole provider of time and frequency equipment for LORAN-C since 2000, with key advancements in eLORAN technology & receivers
    - Led 2014 research contract for on-air eLORAN development w/USG

Leaders in eLoran & PNT: Booz Allen & Continental Electronics

- Booz Allen Hamilton: $6b in annual revenues
  - Primary business areas: Industry leaders in data analytics, engineering, cybersecurity, market development, strategic thought leadership and consulting
  - Broad experience in PNT and future architecture solutioning and implementation for critical infrastructure sectors for DOD/Civil & commercial
  - Deep knowledge in developing and testing eLoran receivers and building use cases for broader applications
- Continental Electronics Corporation (CEC): Founded in 1946, US base manufacturer of low frequency, high power transmitters
  - Primary business areas: US leading manufacture of radio frequency (RF) transmission equipment
    - Specializing in the design, development and manufacture of high power transmitter systems for global military, scientific, industrial and broadcast applications.
    - Well known worldwide legacy of eLoran transmission systems, providing these to the USG and other nations for decades.
    - Have deployed and supported these systems globally for over 70 years

Booz | Allen | Hamilton

Continental Electronics
"A Tradition of RF Innovation"

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Leaders in United Kingdom PNT: Chronos & NLA International

- Chronos Technology Ltd
  - Delivering global synchronisation and timing solutions to telecoms, energy, fintech, broadcast, enterprise IT & defence markets for over 30 years; optimising timing in communications networks and enabling our customers to deliver seamless services
  - Working closely with our global customer base, our team of technical experts provides complete solutions from knowledge, network design, solution specification, system integration, installation & commissioning and 24/7/365 hardware and helpdesk support
  - Experts in GNSS vulnerability mitigation including jamming & spoofing detection & eLoran deployment for timing
- NLA International: Blue Economy Solutions
  - Is a Blue Economy solutions company applying innovative technologies and processes to enable prosperous and sustainable growth in marine, maritime and coastal/littoral domains.
  - Delivering strategy, research, marketing and consultancy services to governments, NGOs and commercial clients.
  - Led the development and publication of the MarRiNav Report, focused on a resilient PNT strategy for the United Kingdom

chronos TECHNOLOGY

NLA INTERNATIONAL

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